PCT/IB04/02155

Europäisches Patentamt | European Patent Office | Office européen des brevets

Bescheinigung | Certificate | Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

03300061.3

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

Anmeldung Nr:
Application no.: 03300061.3
Demande no:

Anmeldetag:
Date of filing: 16.07.03
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

Koninklijke Philips Electronics N.V.
Groenewoudseweg 1
5621 BA Eindhoven
PAYS-BAS

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se referer à la description.)

METHOD AND DEVICE FOR SUPPLYING POWER TO LEDS

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s) revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

H05B33/08

Am Anmeldetag benannte Vertragstaaten/Contracting states designated at date of filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL
PT RO SE SI SK TR LI

METHOD AND DEVICE FOR SUPPLYING POWER TO LEDS

FIELD OF THE INVENTION

The invention generally relates to mobile communications. It particularly relates to a device and method for generating appropriate supply for LEDs (Light Emitting Diodes), which need to be supplied with a forward voltage that is higher than a predefined minimum forward voltage and with a current that is lower than a predefined maximum current.

The invention advantageously applies to any voltage-supplied equipment and especially to battery-supplied equipment, like mobile phones or PDAs (Personal Digital Assistant), for example, having color displays that are backlighted using white LEDs.

BACKGROUND OF THE INVENTION

LEDs need to be supplied with appropriate forward voltage and current limitation. In particular, white LEDs may need a higher forward voltage than the voltage supplied in current battery driven equipment. Known direct current up or down voltage converters, also called DCDC up converters, with current measurement can be used for this purpose. But they are rather expensive.

OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide cost-efficient supply generation means for LEDs.

To this end, a device and a method as defined in the opening paragraph are described. The device comprises:

- voltage supply means for supplying voltage to the LEDs,
- a pulse generator for generating a cyclic pulse signal having predefined on times and off times,
- a switch controlled by the pulse generator to be turned on during said on times to short circuit the LEDs and turned off during said off times,
- an inductive device for increasing the forward voltage over the LEDs when the switch is turned off so that said forward voltage gets higher that the minimum forward voltage and for decreasing said forward voltage when the switch is turned on, so that the current through the LEDs remains below the maximum current.

This arrangement allows supplying the LEDs with sufficient forward voltage and prevents the current to be too high through the LEDS. The pulse generator can be for example a PWM (Pulse Width Modulation) generator. It is often available in current battery-supplied equipment. Therefore, the circuit can be built at very low cost with very few extra components. No special regulation is required provided a trade off between the inductance of the inductive device and the frequency of the pulse generator is achieved with respect to the brightness required of the LEDs.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention and additional features, which may be optionally used to implement the invention, are apparent from and will be elucidated with reference to the drawings described hereinafter, wherein which :

- Fig. 1 is a schematic diagram illustrating a device according to the invention,
- Fig. 2 is a schematic diagram illustrating an improved device according to the invention,
- Fig. 3 is a schematic diagram for illustrating an apparatus including a device according to the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The following remarks relate to reference signs. Like letter references in all Figures designate like entities.

Current batteries do not provide a voltage, which is high enough for white LEDs. However, white LEDS cannot be supplied with a too high current. A trade off between a high voltage and a low current must be achieved. Therefore, a device is needed to increase the voltage over the LEDs without increasing the current over the maximum current that the LEDs can bear.

Fig. 1 is an example of a device according to the invention for lighting white LEDs that need to be supplied with a certain predefined reference minimum forward voltage, but also with a current, which should be below a predefined reference maximum current. Depending on the application and on the voltage needed, one or several LEDs can be used in series. It comprises :

- the LEDs D1 to D4,
- voltage supply means U for supplying a voltage to the LEDs,
- a pulse generator PWM for generating a cyclic pulse signal having predefined on times when the signal is at its higher state and off times when the signal is in its lower state, the pulse generator can be a pulse width modulation generator but not necessarily,

- a switch S1, for example an NMOS FET (Field Effect Transistor conducting current when the gate is driven to a more positive voltage than the source) or NPN bipolar transistor (transistor which is turned on by a positive current into the base, which then allows to conduct current from collector to base) controlled by the pulse generator to be turned on during said on times to charge the inductance L1 and short circuit the LEDs and turned off during said off times,
- an inductive device or coil L1 having an inductance L for increasing the forward voltage over the LEDs when the switch is turned off so that the forward voltage gets higher than the minimum forward voltage and for charging L1 when the switch is turned on, so that the current through the LEDs remains below the reference maximum current.

The supply U has the voltage Vdd. The switch S1 is turned on (is conducting) during the on times of the pulse generator. When S1 is conducting, the coil L1 increases its current by Vdd/L. When S1 is turned off, the current keeps on flowing through the coil L1 and the coil current is decreased by (VLED – Vdd)/ L.

The maximum on time of the signal PWM and the inductance L of the coil L1 has to be chosen so that the maximum coil current is not higher than the maximum current allowed through the LEDs. The off time has to be chosen so that the oil current decreases to 0. If the PWM signal is turned off, the LEDs also turn off. The frequency of the pulse generator has an impact on the brightness of the LEDs. The higher the frequency is, the brighter the LEDs are, because the pulse signal makes the LEDs to be light on and off according to the pulse signal frequency. At high frequencies, a human eye cannot see the LEDs flickering. But they are indeed light on only part of the time, that is only during the off times of the pulse signal, which causes their brightness to be a bit lower than if they were on all the time.

To improve efficiency of the circuit, a diode D can be used before the LEDs as shown in Fig. 2 to prevent that the voltage over the LEDs goes down to zero.

Fig. 3 illustrates a mobile phone apparatus 30 having an IC 31 containing a pulse generator and a color display 32, which is back lighted with the white LEDs D1 to D4, using a device as shown in Fig. 1 or Fig. 2. In Fig. 3, Vg stands for the ground.

The drawings and their descriptions hereinbefore illustrate rather than limit the invention. It will be evident that there are numerous alternatives, which fall within the scope of the appended claims.

Claims.

1. A device for lighting at least one light emitting diode (LED) to be supplied with predefined minimum forward voltage and maximum current, comprising:
- voltage supply means for supplying voltage to the light emitting diode,
- a pulse generator for generating a cyclic pulse signal having predefined on times and off times,
- a switch controlled by the pulse generator to be turned on during said on times to short circuit the light emitting diode and turned off during said off times,
- an inductive device for being charged when the switch is turned on and for increasing the forward voltage over the light emitting diode when the switch is turned off.

2. A device as claimed in claim 1, comprising a diode before the light emitting diode to prevent the voltage over the light emitting diode to go down to zero.

3. A device as claimed in claim 1, wherein the inductive device is a coil having an inductance defined by the number of light emitting diodes and their maximum current and voltage requirements as well as the available frequency of the pulse generator.

4. A device as claimed in claim 1, wherein the cyclic pulse signal has a frequency from 0,1 kHz to 30 Mega Hertz.

5. A device as claimed in claim 1, wherein the pulse generator is a pulse width modulation generator.

6. A device as claimed in claim 1, wherein the switch is a MOS FET or a NPN bipolar.

7. A battery-supplied apparatus comprising a display and a device as claimed in claim 1 for backlighting said display.

8. A method of lighting at least one light emitting diode to be supplied with predefined minimum forward voltage and maximum current, comprising the steps of:
- supplying a forward voltage to the light emitting diode,
- generating a cyclic pulse signal having predefined on times and off times for controlling a switch to be turned on during said on times to short circuit the light emitting diode and turned off during said off times,

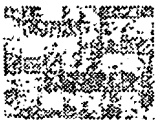
- charging an inductive device when the switch is turned on,
- increasing the forward voltage over the light emitting diode when the switch is turned off so that said forward voltage gets higher than the minimum forward voltage.

Abstract.

The invention relates to a device for lighting at least one light emitting diode to be supplied with predefined minimum forward voltage and maximum current. It comprises:

- voltage supply means for supplying voltage to the light emitting diode,
- a pulse generator for generating a cyclic pulse signal having predefined on times and off times,
- a switch controlled by the pulse generator to be turned on during said on times to short circuit the light emitting diode and turned off during said off times,
- an inductive device for increasing the forward voltage over the light emitting diode when the switch is turned off so that said forward voltage gets higher that the minimum forward voltage and for decreasing said forward voltage when the switch is turned on, so that the current through the light emitting diode remains below the maximum current.

Fig. 1



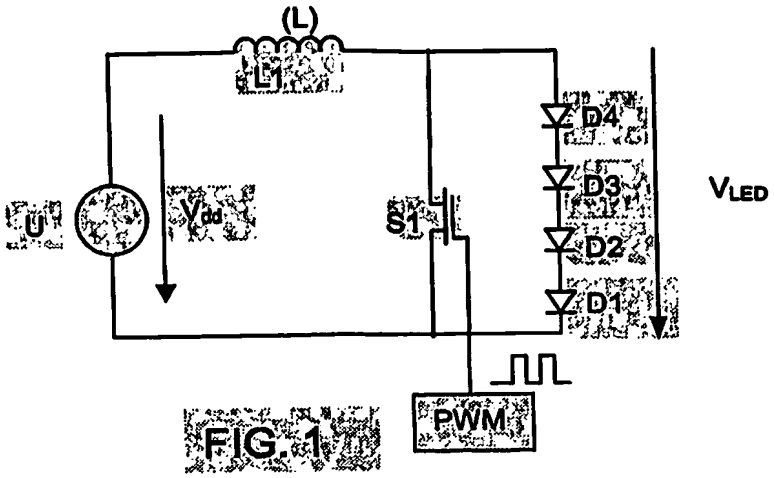


FIG. 1

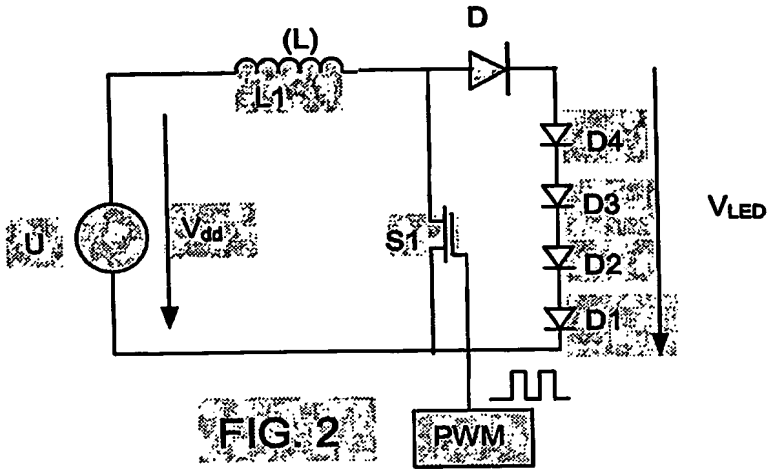


FIG. 2

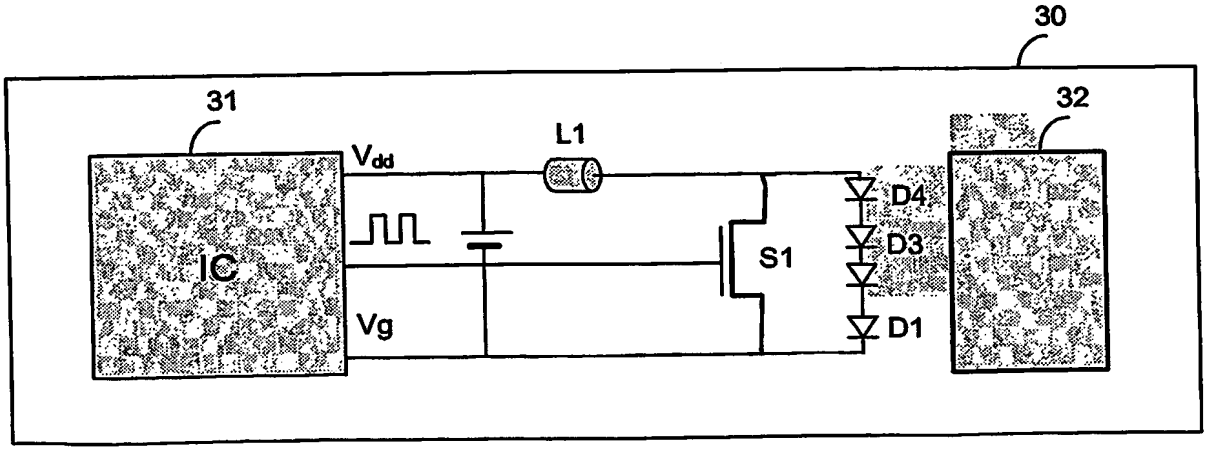


FIG. 3

PCT/IB2004/002155

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☑ FADED TEXT OR DRAWING
- ☑ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☑ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.
As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.